FROM: HQ AFCESA/CES
139 Barnes Drive, Suite 1
Tyndall AFB, FL 32403-5319

SUBJECT: **Engineering Technical Letter (ETL) 98-8: Fire Protection Engineering Criteria - Existing Aircraft Facilities**

**1. Purpose.** This ETL provides fire protection criteria governing existing facilities housing Air Force aircraft or other aircraft on Air Force installations. These criteria provide for protection of adjacent aircraft and the facility in the event of a fuel spill fire. Human intervention is always required to minimize damage to incident aircraft.

**2. Application:** All types of aircraft facilities with installed fire suppression systems, including but not limited to maintenance, servicing, and storage hangars; corrosion control hangars; fuel cell repair hangars; depot overhaul facilities; research and development (R&D)/testing facilities housing aircraft; and all types of aircraft shelters (weather, alert, semi-hardened and hardened). Compliance with this ETL is mandatory for:

- modernization of water and foam-water deluge hangar fire protection systems.
- modernization of aqueous film forming foam (AFFF) hangar fire protection systems
- modernization of high expansion foam hangar fire protection systems.
- modernization of fire protection water pumping systems.
- alteration, addition, renovation, rehab, modernization, and upgrade projects that have not completed the Project Definition (PD) phase.
- alteration, addition, renovation, rehab, modernization, and upgrade projects beyond the PD phase but not in active design status.

Compliance with this ETL should be considered for projects in active design beyond PD. Applying these criteria will result in reduced original construction and life-cycle maintenance costs, and increased overall reliability of the fire protection features.

**2.1.** Existing Facilities Without Suppression Systems: Design and construction of fire protection features for all existing aircraft facilities without installed fire suppression systems will comply to the extent possible with ETL 98-7, *Fire Protection Engineering Criteria - New Aircraft Facilities*.

**2.2.** Occupancy Changes  Change of aircraft does not constitute a change of occupancy. Use this ETL during beddown of a new mission aircraft or change of aircraft type unless the MAJCOM requires use of ETL 98-7. Use ETL 98-7 during major change of occupancy, such as converting a former hangar currently used as a warehouse back to an aircraft hangar.

**2.3.** Other Facilities:  Facilities used exclusively for aero club and similar aircraft (T-3, T-41, TG-3, TG-4, TG-7, TG-9, S-10) within the size limitations for Group III hangars in NFPA 409, *Standard on Aircraft Hangars,* must comply with NFPA 409 requirements for Group III aircraft hangars.

**2.4.** Exempt Facilities:

- Aircraft shelters with two or fewer sides (including partial walls). These shelters will be treated as open ramps.

**2.5.** Authority: AFI 32-1023, *Design and Construction Standards and Execution of Facility Construction Projects*.

**2.6.** Effective Date: Immediately. Expires five years from date of issue.

**2.7.** Recipients: All Major Commands and other Air Force activities.

**NOTE**: Criteria in this ETL assume fire department capabilities consistent with AFI 32-2001, *The Fire Protection Operations and Fire Prevention Program*, and a water supply and fire hydrant configuration at the hangar to support firefighting. Use of these criteria at other locations is not recommended without a complete risk analysis prepared by the base (or the project A-E for new construction) and accepted by the MAJCOM Fire Protection Engineer (FPE) and the MAJCOM Fire Department Operations (FDO) group.

## 3. Referenced Publications.

**3.1.** Air Force:

- AFI 32-1066, *Plumbing Systems*
- AFI 32-2001, *The Fire Protection Operations and Fire Prevention Program*
- AFM 88-29, *Engineering Weather Data*
- Technical Order 1-1-3, *Inspection and Repair of Aircraft Internal Tank and Fuel Cells*

**3.2.** DoD:

- MIL-HDBK-1008C, *Fire Protection for Facilities Engineering, Design, and Construction*
- MIL-F-24385F, *Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea Water*

**3.3.** National Fire Protection Association (NFPA):

- NFPA 11A, *Standard for Medium- and High-Expansion Foam Systems*
- NFPA 13, *Standard for the Installation of Sprinkler Systems*
- NFPA 16, *Standard for the Installation of Deluge Foam -Water Sprinkler and Foam-Water Spray Systems*
- NFPA 16A, *Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems*
- NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*
- NFPA 24, *Standard for the Installation of Private Fire Service Mains and their Appurtenances*
- NFPA 30, *Flammable and Combustible Liquids Code*
- NFPA 31, *Standard for the Installation of Oil Burning Equipment*
- NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
- NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*
- NFPA 54, *National Fuel Gas Code*
- NFPA 70, *National Electrical Code*
- NFPA 72, *National Fire Alarm Code*
- NFPA 90A, *Standard for the Installation of Air Conditioning and Ventilating Systems*
- NFPA 101, *Code for Safety to Life from Fire in Buildings and Structures*
- NFPA 231, *Standard for General Storage*
- NFPA 231C, *Standard for Rack Storage of Materials*
- NFPA 409, *Standard on Aircraft Hangars*

**NOTE:** The latest edition of an NFPA standard applies.

**3.4.** American Society for Testing and Materials (ASTM):

- ASTM A-53, *Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*
- ASTM A-795, *Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*
- ASTM D2996-95, *Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe*

**3.5.** American National Standards Institute (ANSI):

- ASME/ANSI A13.1-1996, *Scheme for the Identification of Piping Systems*
- ASME/ANSI B31.3-1996, *Process Piping*

**3.6.** Private Industry:

- Factory Mutual Loss Prevention Data Sheet 1-22, *Criteria for Maximum Foreseeable Loss Fire Walls and Space Separation*
- Factory Mutual Loss Prevention Data Sheet 1-23, *Protection of Openings*

**4. Specific Requirements.** This ETL, in accordance with paragraph 1.3.4 of MIL-HDBK-1008C, *Fire Protection for Facilities Engineering, Design, and Construction,* takes precedence over MIL-HDBK 1008C, section 4.16. This ETL is the Air Force alternative to National Fire Protection Association Standard 409 and will be used instead of that standard except as noted. Attachment 1 provides criteria and technical guidance.

**4.1.** U.S. Army Corps of Engineers Center of Expertise for Aircraft Hangar Fire Protection.

**4.1.1.** For all hangar Military Construction (MILCON) projects on which the CoE is the Design Agent, the CoE Center of Expertise will review all project designs to ensure compliance with this ETL. This review is mandatory at all design review stages, and all formal review comments issued by the Center of Expertise will be implemented to the satisfaction of the Air Force in accordance with USACE/CEMP 13 July 95 letter, "Fire Protection Design Review for Air Force Hangar Facilities."

**4.1.2.** For all hangar MILCON projects for which the CoE is the Construction Agent, the CoE Center of Expertise will review all contractor shop submittals to ensure compliance with this ETL. All review comments issued by the Center of Expertise will be implemented by the CoE's Contracting Officer to the satisfaction of the Air Force. An FPE in the office of the Center of Expertise will perform the final acceptance testing of all hangar fire protection systems. The MILCON project will not be accepted by the CoE Contracting Officer until the CoE Center of Expertise has accepted the fire protection systems.

**4.2.** Naval Facilities Engineering Command (NAVFACENGCOM) FPE.

**4.2.1.** For all hangar MILCON projects for which NAVFAC is the design agent, the Division FPE will review all project designs to ensure compliance with this ETL. This review is mandatory at all design review stages, and all formal review comments issued will be implemented to the satisfaction of the Air Force.

**4.2.2.** For all hangar MILCON projects, the Division FPE will review all contractor shop submittals to ensure compliance with this ETL. All review comments will be implemented by the Contracting Officer to the satisfaction of the Air Force. An FPE will perform the final acceptance testing of all hangar fire protection systems.

**5. Point of Contact.** Fire protection criteria for aircraft facilities must evolve concurrently with technical developments in fire science, data generated in fire testing programs, and the availability of new fire protection equipment or methodologies. Recommendations for improvements to this ETL are encouraged

and should be furnished to Mr. Fred Walker, HQ AFCESA/CESM, DSN 523-6315, commercial (850) 283-6315, FAX DSN 523-6219, Internet: walkerf@afcesa.af.mil.

Patrick C. Daugherty, P.E.
Director of Technical Support

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1. Technical Criteria
2. Distribution List

**TECHNICAL CRITERIA**
**AIR FORCE AIRCRAFT HANGAR FIRE PROTECTION**

## A1. Construction Requirements.

**A1.1.** Structural Requirements. All new structural and non structural features added, repaired, or replaced must be exclusively noncombustible construction in accordance with the Uniform Building Code (UBC). Facilities used exclusively for aero club and similar aircraft (T-3, T-41, TG-3, TG-4, TG-7, TG-9, S-10) meeting the space requirements of NFPA 409 for Group III structures may comply with criteria in NFPA 409 for Group III hangars and paragraph A3.1.1.5.

**A1.1.1.** Fire-Rated Construction. Protection of structural members (columns, beams, trusses, joists) is not required in a facility protected by an approved fire suppression system in compliance with this ETL.

**A1.1.2.** Internal Fire-Rated Separations. When Air Force aircraft assets are co-located in a facility with non-DOD operations that are beyond the control of the DOD activity, the Air Force aircraft assets will be isolated from the non-DOD areas by 4-hour rated fire walls. Penetrations of such fire walls must be minimized. Any door, window, or other penetration must be protected in accordance with Factory Mutual Loss Prevention Data Sheets 1-22*, Criteria for Maximum Foreseeable Loss Fire Walls and Space Separation*, and 1-23, *Protection of Openings*.

**A1.1.2.1.** To allow the greatest operational flexibility in Air Force hangars covered by this ETL, fire-rated walls and partitions are not required between adjacent aircraft servicing areas when the nature of the occupancy is similar in both bays. Operations such as fuel cell maintenance, ICTs, and indoor refueling must be separated from general maintenance by walls of not less than a 1-hour fire rating with 45-minute opening protection. Such walls will extend from the floor to the underside of the roof deck. Masonry construction is recommended for all separation walls.

**A1.1.2.2.** Except in facilities containing only unfueled aircraft, operations outside the aircraft servicing area must be isolated from the aircraft servicing area by a wall having a fire resistance rating of at least 1 hour. This wall will extend from the concrete floor to the roof. All openings in this wall will be automatic-closing or self-closing and will be rated for at least 45 minutes. Masonry construction is recommended for all separation walls. (These areas must be fully sprinklered in accordance with other sections of this ETL.)

**A1.1.3.** Allowable Floor Area.

**A1.1.3.1.** The allowable floor area of a facility is unlimited when all of the following conditions are met:

- 100 percent of the facility is protected in accordance with this ETL;
- water supply to the sprinkler systems is in full compliance with the criteria in this ETL;
- separations from adjacent structures comply with paragraph A1.1.4 of this ETL;
- internal separation walls comply with paragraph 1.1.2 of this ETL.

**A1.1.3.2.** Facilities not meeting the above conditions are limited to the floor areas contained in the latest edition of the Uniform Building Code for Occupancy type S-5; except facilities used for fuel cell maintenance, integrated combat turns, or indoor refueling/defueling, which are Occupancy type H-5. The MAJCOM must aprove continued use of existing facilities exceeding these limits.

**A1.1.4.** Siting/Separation. Separation Between Adjacent Hangars. No separation distance is required between any combination of Type I or Type II construction hangars protected by approved fire suppression systems.

**A1.1.4.1.** Separation Between Adjacent Maintenance Hangars of Mixed Construction. The minimum separation distance between adjacent hangars is 12 meters (40 feet). This may be reduced to 7.5 meters (25 feet) if one of the hangars has a 1-hour exposure wall and protected 3/4-hour openings (e.g., windows, doors), or if both hangars have approved fire suppression systems. This may be further reduced to 3 meters (10 feet) if both hangars have 1-hour exposure walls and protected 3/4-hour openings.

**A1.1.4.2.** Separation Between Hangars and Other Buildings. Minimum separation between hangars and other buildings is 12 meters (40 feet). Reductions in this distance must conform to the Uniform Building Code.

**A1.1.4.3.** Separation Between Tension Fabric Hangars and All Other Structures. Minimum separation between tension fabric structures and other structures is 30 meters (100 feet) with a clear zone of 15 meters (50 feet) immediately adjacent to the tension fabric structure. The clear zone can not be used for storage and must be clear of vegetation. (Maintained lawn is permitted.) The clear zone may be used as a street or driveway, but not for vehicle parking.

**A1.1.5.** Draft Curtains.

**A1.1.5.1.** Ensure the integrity of existing draft curtains.

**A1.1.5.2.** Provide draft curtains, if none are installed, for closed-head fire suppression systems surrounding each sprinkler system. Extend draft curtains down from the roof (or ceiling) not less than one-eighth of the distance from the roof (or ceiling) to the floor. When roof structural supports extend below the roof or ceiling, suspend draft curtains to the lowest member of the structural supports, or one-eighth of the distance from the roof (or ceiling) to the floor, whichever is greater. Install draft curtains to form rectangular roof pockets. Install draft stops on the exposed structural roof supports whenever possible.

**A1.1.6.** Exits. Ensure egress and egress marking complies with the current edition of the Life Safety Code, Industrial Occupancies Chapter, Special Provision for Aircraft Servicing Hangars.

**A1.2.** Utility Systems.

**A1.2.1.** Floor Drainage.

**A1.2.1.1.** Aprons and the approach into the hangar must be sloped away from the hangar with a grade of not less than one half of one percent (0.3:60 meters [1:200 feet]) to preclude a ramp fuel spill entering the hangar. If the required grade cannot be achieved, provide an appropriately sized trench drain across the entire apron side of the hangar with a discharge to a safe location remote from the hangar.

**A1.2.1.2.** Floor elevations within the hangar must be arranged to prevent a liquid spill within the aircraft servicing area from flowing into adjacent areas.

**A1.2.1.3.** Hangars protected by water deluge systems must provide floor drainage in the aircraft servicing area to remove fuel spills. A properly coordinated design allows a fuel spill to flow away naturally from the aircraft and the facility walls. Slope hangar floors away from the aircraft shadow area and away from hangar walls. Floors must be sloped to direct spilled fuel away from the aircraft to the nearest drain; slope floors one-half to one percent. Coordinate the location of drains with aircraft parking positions. The hangar floor drainage system must discharge far enough from the hangar to preclude a fire exposure to the hangar or any other structure.

**A1.2.2.** Heating Systems.

**A1.2.2.1.** Ensure heating equipment is installed and operating in accordance with manufacturer's instructions, NFPA 90A*, Standard for the Installation of Air Conditioning and Ventilating Systems*; NFPA 31, *Standard for the installation of Oil Burning Equipment*; and NFPA 54, *National Fuel Gas Code*,as appropriate.

**A1.2.2.2.** Replace heaters with a flame or glowing element open to the atmosphere in the aircraft servicing area.

**A2.2.2.3.** If radiant heating is desired, overhead radiant tube heating systems drawing and exhausting combustion air to the exterior of the hangar are recommended.

**A1.2.3.** Electrical Systems.

**A1.2.3.1.** Ensure all electrical equipment in the aircraft hangar complies with NFPA 70, *National Electrical Code,* based on the original installation criteria. Additions and modifications to the electrical service in the aircraft servicing areas must conform to the original installation criteria.

**A1.2.3.1.1.** Most hangars constructed prior to 1983 were Class I Division 1 up to four feet, and common industrial practices above four feet and in adjacent areas.

**A1.2.3.1.2.** Most hangars constructed between 1983 and 1996 were Class I Division 2 up to eighteen inches and up to the height of the door, except within two feet of the walls. Within two feet of the walls and in adjacent areas suitably cut off, common industrial practices were followed. Fuel systems maintenance facilities were an exception, where all electrical equipment in the aircraft servicing area was Class I Division 2 to the height of the hangar door.

**A1.2.3.1.3.** Most hangars constructed since 1996 comply with NFPA 70, Article 513.

> Note: Technical Order 1-1-3*, Inspection and Repair of Aircraft Internal Tank and Fuel Cells*, further requires all outlets in the aircraft fuel system maintenance servicing areas to be Class 1 Division II-rated. This is an aircraft maintenance (user) safety requirement, not a fire safety issue. Questions should be directed to the command fuels system maintenance office or the T.O. Manager at Warner Robins Air Logistics Center.

**A1.2.3.2.** If electrical service is required in the aircraft servicing area, install electrical equipment in general maintenance aircraft hangars in accordance with NFPA 70, Article 513, except as noted below.

**A1.2.3.2.1.** Install electrical equipment in hangars for fuel system maintenance operations involving aircraft serviced with JP-8 (or another combustible fuel at a temperature below its flash point) in accordance with NFPA 70, the National Electric Code NEC Article 513.

NOTE: Technical Order 1-1-3 further requires all outlets in the aircraft servicing area to be Class 1 Division II rated. This is an aircraft maintenance (user) safety requirement, not a fire safety issue; questions should be directed to the command fuels system maintenance office or the T.O. Manager at Warner Robins Air Logistics Center.

**A1.2.3.2.2,** Requirements in paragraphs A1.2.3.2.2.1 and A1.2.3.2.2.2 apply to installed electrical equipment in hangars with the following operations:

- refueling or defueling regardless of fuel type (other than fuel system maintenance);
- Integrated Combat Turns (ICTs) regardless of fuel type, and
- fuel system maintenance operations with flammable fuels including JP-4 (or a combustible fuel at a temperature above flash point).

**A1.2.3.2.2.1.** Electrical equipment in the aircraft servicing area above the floor up to the height of the highest hangar door must satisfy NEC criteria for Class I Division 2 locations.

**A1.2.3.2.2.2.** Electrical equipment outside the classified area in the aircraft maintenance area, including lights, must conform to NEC Article 513.

**A1.2.3.3.** In hangars where the rate of spray paint application exceeds one quart per hour or the cumulative application of more than one gallon over an eight-hour period, install electrical equipment in accordance with NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*.

**A2. Accessibility for Firefighting**.

**A2.1.** Hangar Doors. Hangar doors must operate under emergency conditions. The electrical supply for power-operated doors must be independent of the building power supply to permit isolation of power to the facility during a fire without interrupting power to door motors.

**A2.1.1.** Configure hangar doors for manual operation without special tools or disassembly.

**A2.1.2.** Use door track heaters in areas subject to freezing to prevent accumulated snow and ice from impeding operation of hangar doors.

**A2.1.3.** Provide a key-operated power switch on the hangar exterior.

**A2.2.** Personnel Doors. To provide adequate access into the hangar for normal structural firefighting operations, personnel doors will satisfy requirements of the

Life Safety Code, Industrial Occupancies Chapter, Special Provisions for Aircraft Servicing Hangars Section (NFPA 101*, Code for Safety to Life from Fire in Buildings and Structures*).

**A3. Fire Suppression Systems.**

**A3.1.** Requirements.

**A3.1.1.** Applicable Design Standards and Criteria. Ensure fire suppression systems are installed and operating in accordance with manufacturer's instructions and the original design criteria, except water deluge systems, which should be modernized in accordance with this ETL. All adjacent areas of the hangar must have automatic sprinkler protection. Sprinkler protection must be designed for the occupancy hazard present in accordance with this ETL, MIL-HDBK 1008C, and the following NFPA Standards:

- NFPA 13, *Standard for the Installation of Sprinkler Systems*
- NFPA 16A, *Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems*
- NFPA 30, *Flammable and Combustible Liquids Code*
- NFPA 33, *Standard for Spray Application Using Flammable or Combustible Materials*
- NFPA 34, *Standard for Dipping and Coating Processes Using Flammable or Combustible Liquids*
- NFPA 231, *Standard for General Storage*
- NFPA 231C, *Standard for Rack Storage of Materials*

Where there is a conflict between this ETL and an NFPA standard or code, this ETL takes precedence.

**A3.1.1.1.** Protect areas used exclusively for unfueled aircraft (in accordance with Technical Order 1-1-3) with conventional wet-pipe sprinkler systems designed for Ordinary Hazard Group 2 occupancy (8.0 lpm/$m^2$ over 270 square meters [0.2 gpm/$ft^2$ over 3000 square feet]).

**A3.1.1.2.** Protect dedicated single-aircraft facilities used exclusively for non-destructive inspection (NDI) (e.g., x-raying) of fueled aircraft with no aircraft maintenance or servicing operations with conventional wet-pipe sprinkler systems designed for Extra Hazard Group 1 occupancy (12.0 lpm/$m^2$ over 270 square meters [0.3 gpm/$ft^2$over 3000 square feet]).

**A3.1.1.3.** Protect areas used for fueled aircraft with any of the following.

**A3.1.1.3.1.** A conventional water deluge sprinkler system delivering not less than 7.0 lpm/$m^2$ (0.17 gpm/$ft^2$) modernized in accordance with this ETL. System must comply with the NFPA 13, *Standard for the Installation of Sprinkler Systems,* current at the time of system acceptance.

**A3.1.1.3.2.** A closed-head foam-water sprinkler system delivering not less than 6.5 lpm/$m^2$ (0.16 gpm/$ft^{2)}$ with a hangar floor-to-ceiling height less than 40 feet. System must comply with the NFPA 16A, *Standard for the Installation of Closed-Head Foam-Water Sprinkler Systems,* at the time of system acceptance. Hangars over 40 feet in height must also have a low level foam-water nozzle system (A3.1.1.3.5).

**A3.1.1.3.3.** A deluge foam-water sprinkler system delivering not less than 6.5 lpm/$m^2$ (0.16 gpm/$ft^2$). System must comply with the NFPA 16, *Standard for the Installation of Deluge Foam-Water Sprinkler Systems,* at the time of system acceptance.

**A3.1.1.3.4**. A high-expansion foam system providing a minimum foam depth of 1 meter (3 feet) over the entire aircraft servicing area and adjacent undivided areas. System must comply with the NFPA 11A, *Standard for Medium and High Expansion Foam System,* current at the time of system acceptance.

**A3.1.1.3.5.** A low level foam-water nozzle system delivering 4.0 lpm/$m^2$ (0.1 gpm/$ft^2$) over the aircraft servicing area. These are found in many hangars together with either a closed-head foam-water sprinkler system, a deluge foam-water sprinkler system, or an automatic sprinkler system; and, in a few cases, without any supporting system.

**A3.1.1.4.** Protect Group III hangars used exclusively for aero club and similar aircraft (T-3, T-41, TG-3, TG-4, TG-7, TG-9, S-10) with conventional wet-pipe sprinkler systems designed for Extra Hazard Group 1 occupancy (12 lpm/$m^2$ over 270 square meters [0.3 gpm/$ft^2$ over 3000 square feet]).

**A3.1.2.** Manual Foam-Water Fire Hose Stations. Neither interior nor exterior foam-water hose stations or fire hose connections are required. Remove existing manual foam-water fire hose stations.

**A3.1.3.** Fire Department Connections. Fire department connections on foam-water systems are not required. Existing fire department connections should remain unless repair is necessary, when they should be removed.

**A3.1.4.** Test Header. Provide a test header for all foam-water systems. Locate the header inside the aircraft servicing area as near as practical to an outside door.

Configure the test header to permit individual testing of each proportioner. Each test header must have at least four, valved 2.5-inch (no equal metric standard) hose fittings.

**A3.1.5.** Underground Piping. Ensure underground piping systems are installed and operating in accordance with NFPA 24*, Standard for the Installation of Private Fire Service Mains and their Appurtenances*, and the following:

**A3.1.5.1.** Provide ductile iron pipe or other pipe listed by Underwriters Laboratories or approved by Factory Mutual for buried fire service application for all underground uses. Replace unapproved piping.

**A3.1.5.2.** Replace any piping passing through the hangar floor where pipe or tie rods are in contact with the earth/concrete interface. Ensure all tie rods meet size and number requirements of NFPA 24. Do not install any new piping under hangar/facility floor slabs. If piping must be located below the floor line, use concrete trenching with open steel grating. Do not install any piping, including the fire protection water service entrance into the building, that allows pressurization of the space below the floor slab. Minimize new piping under paved operational surfaces (taxiways and aircraft parking).

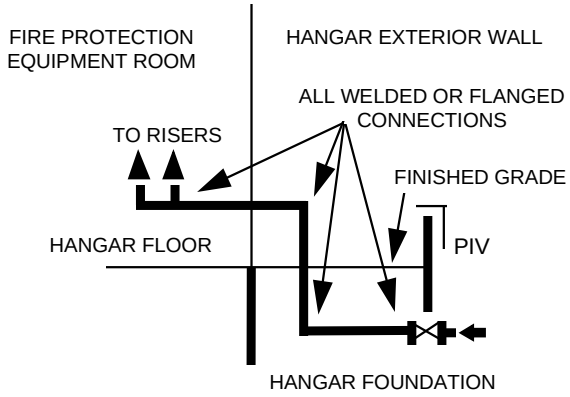



Figure A1. Water Supply Pipe Entry

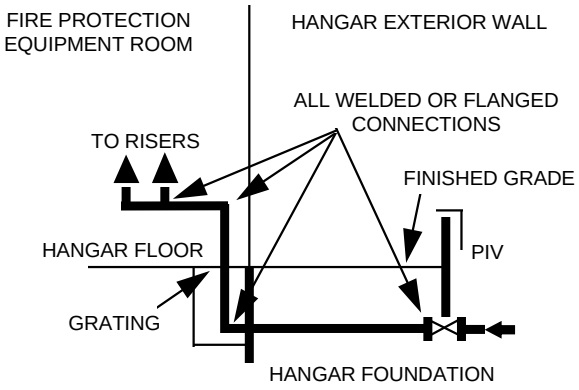



Figure A2. Water Supply Pipe Entry

**A3.1.5.3.** Size new underground mains to ensure maximum flow velocity does not exceed 3 meters per second (10 feet per second).

**A3.1.5.4.** Use flanged fittings (Figures A1 and A2) to transition the fire protection water service entrance from horizontal to vertical as it enters the building. Do not use gasketed compression fittings (including locking type) or flanged fittings with set screws. Existing gasketed compression fittings and flanged fittings with set screws may remain, provided there is no evidence of movement or wear.

**A3.1.5.5.** Ensure corrosion protection systems are installed and operating according to manufacturer's guidance. Provide corrosion protection on new underground fire mains in the same manner as required for domestic water and other buried piping at the location.

**A3.1.5.6.** Do not install new piping carrying foam concentrate or foam-water solution underground.

**A3.1.6.** Backflow Prevention. Install backflow prevention devices at connections to domestic water distribution systems. Valves that are part of a backflow prevention assembly must be an indicating type and be supervised. Omit post indicator valves when backflow preventers are located outside. Locate backflow preventers inside the protected buildings when freeze protection is required. Do not use heat tapes or tracings to provide freeze protection; however, in locations where simple insulation provides adequate freeze protection, the backflow preventer may be located outside. (See AFI 32-1066, *Plumbing Systems.)*

**A3.1.6.1.** Use reduced-pressure backflow preventers with new connections between potable water systems and systems containing foam.

**A3.1.6.2.** Unless otherwise required by local health/water authorities, use double-check valve assemblies with new connections between potable water systems and systems that do not contain chemicals (e.g., wet pipe systems).

**A3.1.6.3.** Install backflow prevention on the discharge side of pumps supplied directly from domestic water systems.

**A3.1.7.** Interior Piping Systems.

**A3.1.7.1.** Limit maximum flow velocity in new interior facility piping to 6 meters per second (20 feet per second) or less.

**A3.1.7.2.** Water and foam-water solution piping must be standard-weight pipe conforming to ASTM A-795, *Black and Hot-Dipped Zinc-Coated (Galvanized) Welded and Seamless Steel Pipe for Fire Protection Use*, or ASTM A-53, *Pipe, Steel, Black and Hot-Dipped, Zinc-Coated, Welded and Seamless*. Do not use galvanized pipe for foam-water solution. Use threaded, flanged, or grooved fittings. Do not use fittings which couple plain end pipe. Do not use welded sprinkler fittings or outlets for foam-water solution.

**A3.1.7.3.** Foam concentrate pipe must be either grooved, welded, or flanged stainless steel or filament-wound fiberglass, satisfying or exceeding ASTM D2996, *Filament-Wound "Fiberglass" (Glass-Fiber-Reinforced Thermosetting-Resin) Pipe)*,

designation code “RTRP-11 FF-3121,” installed in accordance with ASME/ANSI B31.3, *Process Piping*.

**A3.1.7.4.** Paint all exposed interior piping (color to be the same as the walls/ceiling or a complementing color) and mark all exposed interior piping indicating the type of fluid carried and direction of flow. Stainless steel and fiberglass piping may be cleaned and left unpainted. Plastic wraparound-type pipe labels must conform to ASME/ANSI A13.1-1996, *Scheme for the Identification of Piping Systems*. Labels are not required on sprinkler system branch lines and pipes less than 2 inches (5.08 centimeters) nominal size. The following legends are required:

- FIRE PROTECTION WATER - used on dedicated potable and non-potable fire protection water lines.
- FOAM CONCENTRATE - used on AFFF/FOAM concentrate lines.
- FOAM-WATER NOZZLE - used on lines supplying supplementary foam-water nozzles.
- FOAM-WATER SPRINKLER - used on lines supplying overhead AFFF/FOAM wet pipe, deluge, and pre-action sprinkler systems.
- FIRE SPRINKLER or SPRINKLER FIRE - used on standard wet pipe systems.

**A3.2.** Deluge Automatic Sprinkler Systems.

**A3.2.1.** Replace all drop-hammer deluge valves (Grinnell Corporation and Automatic Sprinkler Corporation Model C) with externally resetable (without opening the valve assembly and without the use of special tools) electrically-activated deluge (automatic water control) valves. Maximum valve size is six inches.

**A3.2.2.** Replace all gaskets, clappers, seats, and seals on all other deluge valves over 20 years old.

**A3.2.3.** Limit the area protected by an overhead sprinkler system to a maximum of 1400 square meters (15,000 square feet) per riser. When multiple systems are required in an aircraft servicing area, all overhead systems should cover essentially equal floor areas.

**A3.3.** Wet Pipe and Pre-action Automatic Sprinkler Systems (Water Only and Foam-Water).

**A3.3.1.** Use a wet-pipe automatic sprinkler system in geographic areas having a 99% dry bulb temperature greater than -17.7 °C (0 °F) (per AFM 88-29, *Engineering Weather Data*). See paragraph A5.4 pertaining to building temperature

supervision when the 99% dry bulb temperature is less than -0.5 °C (33 °F)(per AFM 88-29).

**A3.3.2.** Use a pre-action automatic sprinkler system activated by a roof- or ceiling-level thermal detection system as described in paragraph A3.7.2 of this ETL in geographic areas having a 99% dry bulb temperature less than -17.7 °C (0 °F) (per AFM 88-29).

**A3.3.2.1.** Provide externally re-setable (without opening the valve assembly and without the use of special tools) automatic water control (deluge) valves for pre-action systems. Maximum valve size is six inches.

**A3.3.2.2.** Do not provide supervisory air on pre-action sprinkler systems or remove an existing installation in aircraft servicing areas.

**A3.3.4.** Replace sprinklers at the roof or ceiling level with quick response sprinklers having temperature ratings of 79.4 °C (175 °F).

**A3.3.5.** Replace all gaskets, clappers, seats, and seals on all valves over 20 years old.

**A3.3.6.** Ensure each system has an inspector test valve and all sections of piping not draining back to the main drain have low point drains.

**A3.3.7.** Ensure a diaphragm pressure/surge accumulator/suppressor tank of not less than 38-liter (10-gallon) capacity is provided for each separate wet pipe or pre-charged system riser.

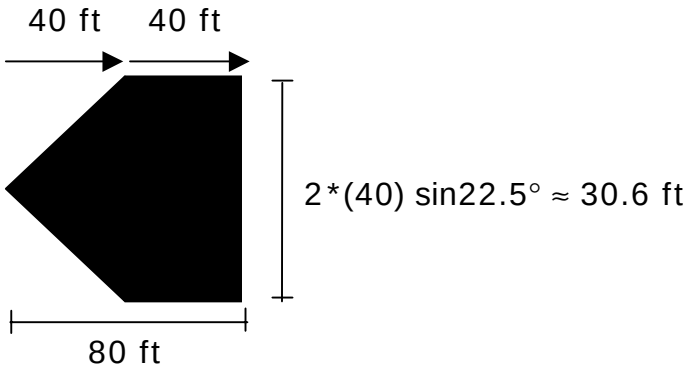
**A3.4**. Low Level Foam-Water Nozzle Systems.

**A3.4.1.** Limit new/replacement individual foam-water nozzle flow rates to less than 1900 lpm (500 gpm). Replace automatic oscillating nozzles with multiple fixed nozzles at the same location. Oscillating monitor non-aspirating foam-water nozzles may only be used when fixed nozzles cannot provide the required coverage.

**A3.4.2.** Ensure the foam-water system is pre-charged with foam-water solution up to the automatic water control valve (deluge valve), located at each foam-water nozzle. Systems with remote automatic water control valves may remain.

**A3.4.3.** The foam-water application rate from foam-water nozzle systems must be not less than 40 lpm/$m^2$ (0.10 gpm/$ft^2$) over the protected area.

**A3.4.3.1.** In aircraft servicing areas dedicated to a single aircraft having a fixed parking position, cover the entire shadow area of the aircraft. The area under engines extending beyond the wing edge and under rear elevators does not have to be considered in the aircraft's shadow area. It is not necessary for the foam-water nozzle discharge pattern (throw) to cover the aircraft shadow area – the foam is more effective in suppressing fuel spill fires when it flows across the floor into the shadow area. Apply the foam-water nozzle discharge no closer than 3 meters (10 feet) from the edge of the shadow area and push the foam under the aircraft. Base the foam-water nozzle coverage on twice the throw distance (*d*) and the width at the widest point, or $2d \sin(\theta/2)$, where $\theta$ is the nozzle pattern in degrees. For example, if the manufacturer's literature indicates a nozzle has a 45 degree pattern and discharges 40 feet, $d = 40$ and $\theta = 45$.




**A3.4.3.2.** In aircraft servicing areas with flexible parking positions or a variety of aircraft, cover the entire floor area up to 6 meters (20 feet) from the walls.

**A3.4.3.3.** Use fixed non-aspirating nozzles or fixed short-barrel aspirating nozzles. Select foam-water nozzle size and locations to provide maximum efficiency in covering the aircraft shadow area(s) without distributing foam onto any aircraft surface.

**A3.4.3.3.1.** Align foam-water nozzle elevations to push the foam across the floor with minimal agitation of the pool fire. It is critical that foam-water nozzles be located and positioned so as not to spray foam-water solution onto any aircraft surface, especially inside aircraft engines, doors, or hatches.

**A3.4.3.3.2.** Locate foam-water nozzles to avoid obstructions (structural components, aircraft components) interfering with the discharge pattern.

**A3.4.3.3.3.** Install new foam-water nozzles at least 3 meters (10 feet) away from the wall to permit storage of aerospace ground equipment (AGE), tools, and aircraft components behind the foam-water nozzles. This minimizes the floor area which

must be kept clear and allows the facility user unrestricted use of more floor space. Install piping to foam-water nozzles in trenches in the floor covered with steel grating. Do not run piping under concrete floors.

**A3.4.3.3.4.** Provide bollards to protect foam-water nozzle locations. Locate bollards so that all parts of the foam-water nozzle assembly, including the full sweep of any oscillating nozzle, are within the bollards' protection.

**A3.4.3.4** Remove manual activation devices as part of the listed valve trim installed on each deluge valve.

**A3.4.4.** Activate foam-water nozzle systems using any one of the following:

- manual foam activation stations at main exits from aircraft servicing area
- waterflow signals in wet-pipe overhead systems
- roof- or ceiling-level heat detection systems in overhead systems.

**A3.5.** High Expansion Foam Systems.

**A3.5.1.** High expansion foam systems are designed as total flooding systems in accordance with NFPA 11A.

**A3.5.2.** High expansion foam systems must deliver sufficient foam to cover the aircraft servicing area and adjacent accessible areas to a depth of 1 meter (3 feet) in 4 minutes or less.

**A3.5.2.1.** Concentrate and water supply must permit continuous operation of the system to generate four times the submergence volume (A3.5.2) for not less than 15 minutes. No additional foam is required for maintenance of the submergence volume beyond this 15 minutes.

**A3.5.2.2.** Connected reserve concentrate supplies are not required.

**A3.5.3.** Generators should be designed to utilize outside air for foam generation except where snow accumulation on the roof is a concern. Generators may be either hydraulically (water) or electrically powered. Electrically powered generators should be supplied ahead of the building disconnect and do not require a secondary power source when the power source meets the reliability requirements in paragraph A4.3.2.1.

**A3.5.4.** Activation. Activate high expansion foam systems using any one of the following:

- manual foam activation stations located at main exits from aircraft servicing area
- waterflow signals in overhead systems
- roof- or ceiling-level heat detection systems in overhead systems (if installed).

**A3.6.** Foam Proportioning Systems.

**A3.6.1.** Listing. All components and assemblies used in this fire protection subsystem must be specifically listed/approved for their intended use by a nationally recognized testing organization whose listing/approval process includes follow-up factory inspections to ensure that products comply with the listing/approval conditions.

**A3.6.2.** Foam Concentrates.

**A3.6.2.1.** AFFF. Use only aqueous film-forming foam (AFFF) concentrates complying with the current military specification (MIL-F-24385F, *Fire Extinguishing Agent, Aqueous Film-Forming Foam (AFFF) Liquid Concentrate, for Fresh and Sea Water*).

**A3.6.2.2.** High Expansion. Use only high expansion foam (Hi-Ex) concentrates listed/approved for use with the foam generators installed.

**A3.6.2.3.** Protein. Use only listed/approved protein foam concentrates.

**A3.6.3.** Proportioning.

**A3.6.3.1.** Locate new proportioners on overhead foam-water sprinkler systems downstream of the alarm check valve or automatic water control valve. Proportioners are limited to 15.24 centimeters (6 inches) or less.

**A3.6.3.2.** Use in-line balanced pressure proportioners (ILBP) on all pumped concentrate systems. Do not use ILBP proportioners on bladder tank systems. ILBP proportioners must be factory assembled and tested by the manufacturer, and the entire ILBP proportioner assembly must be listed/approved by a recognized laboratory. Disassembly, reassembly, and/or modification by the installing contractor is prohibited.

**A3.6.3.2.1.** Concentrate pumping systems must deliver the required flow when the largest concentrate pump is out of service.

**A3.6.3.2.2.** Provide a pressure maintenance pump when the length of concentrate piping between the concentrate pump and the point of injection exceeds 14.5 meters (50 feet).

**A3.6.4.** Control Valve. Use water-powered ball valves as foam concentrate control valves. The valve must be operated by connection to the alarm line of the automatic water control valve or alarm valve. Provide a retard chamber in the line to the water-powered ball valve on wet pipe foam water systems.

**A3.6.5.** Concentrate Quantity.

**A3.6.5.1.** For foam-water sprinklers and foam-water nozzles, provide a connected foam concentrate supply sized for not less than a single 10-minute application of foam, based on the actual system flow in the hydraulically least demanding area.

**A3.6.5.2.** For high expansion generators, provide a connected foam concentrate supply sized for not less than a single 15-minute application (or four times the submergence volume, whichever is greater) of foam.

**A3.6.6.** Concentrate Storage. Provide a single foam concentrate tank. New atmospheric foam storage tanks must be either plastic or fiberglass construction and listed/approved for storage of foam concentrate. Pressure tanks for bladder tank systems must be steel, and listed/approved for storage of foam concentrate.

**A3.6.6.1.** Do not provide back-up supply of foam concentrate in the facility, either as a connected reserve or bulk reserve. Remove connected reserve supply tanks and piping.

**A3.6.6.2.** Limit new bladder tanks to the horizontal type only. Provide clear space at one end of the tank, at least equal to the length of the tank, to permit bladder replacement. Doors to the outside at the end of the tank are an acceptable alternative.

**A3.7.** Foam System Detection and Controls.

**A3.7.1.** Fire Suppression System Control Panel (FSSCP). Replace all FSSCPs over 20 years old. Newer panels which the manufacturer has ceased to service and support must also be replaced. Design all replacement foam system detection and controls to comply with NFPA 72, *National Fire Alarm Code*, and the following criteria.

**A3.7.1.1.** Locate all new FSSCPs in the fire protection equipment room, in a clean environment with temperature and humidity control in accordance with the unit's listing/approval.

**A3.7.1.2.** Transient Voltage Surge Suppression (TVSS).

**A.3.7.1.2.1.** FSSCPs must have TVSS on fire alarm circuits entering and leaving the facility, including (but not limited to) the power supply circuits to the FSSCP, circuits interfacing with fire pumping stations outside the facility, and circuits interfacing with the fire alarm receiving station (such as communication circuits or antenna systems).

**A.3.7.1.2.2.** Alternating Current (ac) Power TVSS Devices. These devices must be tested in accordance with UL 1449 (Second Edition) and UL 1283 (latest edition) by a nationally recognized testing laboratory. TVSS devices must provide normal sine wave tracking, with Category A1 ring wave suppression (2,000 volts, 67 amperes, 180 degrees) of less than 50 volts for nominal 120-Vac legs. The TVSS will provide independent, distinct, and dedicated circuitry for each possible protection mode (i.e., line-to-line, line-to-neutral, line-to-ground, neutral-to-ground). TVSS device circuitry must be fully encapsulated for protection of the circuitry and to provide longer life expectancy.

**A.3.7.1.2.3.** Data, Signal, and Control Wire TVSS Devices. The TVSS device must be designed by the same manufacturer as the ac power TVSS devices to ensure overall compatibility and system reliability. The TVSS manufacturer will provide the TVSS devices based on evaluation of individual system parameters, including: conductor size and length, number of conductors, shield type, peak current and voltage, signal type, signal baud rate, frequency bandwidth, maximum attenuation, maximum standing-wave-ratio, and maximum reflection coefficient. TVSS device circuitry must be fully encapsulated for protection of the circuitry and to provide longer life expectancy.

**A3.7.1.3.** Provide an FSSCP for all suppression and detection functions in the aircraft area. The FSSCP must be fully compatible with the base fire alarm receiving system, without field modifications to any system hardware or software.

**A3.7.1.3.1.** The FSSCP must transmit a separate and distinctive fire signal to the fire department upon activation of any portion of the hangar fire suppression system. Separate fire alarm transmitters/receivers are permitted when they are fully compatible with the FSSCP and the base fire alarm receiving system without field modifications.

**A3.7.1.3.2.** The specific number of alarm signals (e.g.; fire, supervisory, tamper) to be transmitted will be defined in the locally developed system matrix (Figures A3 and A4).

| | SYSTEM INPUTS | ANNUNCIATION AT LOCAL PANELS | | | | | FIRE SUPPRESSION SYSTEM FUNCTIONS | | | | | TRANSMIT SIGNALS TO FIRE DEPARTMENT | | | | | | | AUXILIARY FUNCTIONS | | | EVACUATION SIGNALS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Audio-Visual Fire Alarm Indication by Zone | Audio-Visual Trouble Indication by Zone | Audio-Visual Common Trouble Indication | Audio-Visual Alarm Indication by Device | | Transmit Pump Start Signal to Pumphouse | Open Pre-Action Sprinkler Valves | Open Low Level Spill Fire Suppression System Valve | Divert Drain Flow from Separators to Containment | | Common Trouble Signal Per Building | Common Supervisory Signal Per Building | Common Fire Alarm Per General Area | Sprinkler Water Flow Per General Area | UV/IR Flame Detectors Per General Area | Foam-Water Discharge Per General Area | | Shut Down All Supply & Recirculating Fans | Release magnetically Held Smoke Doors | | Facility Fire Evacuation Audio-Visual Signal | Foam System Signal Blue Strobe/Beacon | |
| | FIRE ALARMS | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W |
| 1 | Manual Fire Alarm Stations | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Spot-Type Smoke Detectors | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Fixed Temp & Rate-of-Rise Type Heat Detectors | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | In-Duct Smoke Detectors | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Rate-Compensated Type Heat Detectors on Hangar Ceiling | | | | | | | | | | | | | | | | | | | | | | | |
| 6 | Water Flow Switches - Wet or Dry-Pipe Sprinkler Systems | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Water Flow Switches - Wet-Pipe Foam-Water Sprinkler Systems | X | | | | | X | | X | X | | | | | | | X | | X | X | | X | X | |
| 8 | Water Switches - Low Level System | X | | | | | | | X | X | | | | | | | X | | X | X | | X | X | |
| 9 | Manual Foam Discharge Station for Nozzles | X | | | | | X | | X | X | | | | | | | X | | X | X | | X | X | |
| 10 | Low Level Optical Fire Detector | | | | X | | | | | | | | | | | X | | | | | | X | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | |
| | SUPERVISORY SIGNALS | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Valve Supervisory Switch - Wet or Dry-Pipe Sprinklers | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | Valve Supervisory Switches -Foam-Water Sprinklers | | X | | | | | | | | | | X | | | | | | | | | | | |
| 14 | Valve Supervisory Switches - Underwing Foam-Water Nozzles | | X | | | | | | | | | | X | | | | | | | | | | | |
| 15 | Valve Supervisory Switches - Water Supply Entrance | | X | | | | | | | | | | X | | | | | | | | | | | |
| 16 | Hi-Lo Pressure Switches - Dry-Pipe Sprinklers | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | Temperature Monitoring System | | | | X | | | | | | | | X | | | | | | | | | | | |
| 18 | UV/IR Flame Detector Trouble | | X | | | | | | | | | | X | | | | | | | | | | | |
| 19 | Control Component Common Trouble Condition | | X | | | | | | | | | | X | | | | | | | | | | | |
| 20 | Low Level Auto Disable Switch | | X | | | | | | | | | | X | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | |
| | TROUBLE CONDITIONS | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | Low Battery Voltage | | | X | | | | | | | | X | | | | | | | | | | | | |
| 23 | Circuit Fault | | X | X | | | | | | | | X | | | | | | | | | | | | |
| 24 | Supervised Component Failure | | | X | | | | | | | | X | | | | | | | | | | | | |
| 25 | AC Power Failure | | | X | | | | | | | | X | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES:

1. Fire alarm signals and supervisory alarm signals shall be clearly differentiated at the fire alarm control panel(s).
2 General area means the specific bay, dock, mezzanine, office area, or mechanical area. System zoning shall be sufficient to direct responding firefighters directly to the fire area.
3, This sample matrix shows the basic requirements and is expected to be tailored to each individual project.

Figure A3. Sample Wet-Pipe FSCP Controls Matrix

## SYSTEM INPUTS

| | | ANNUNCIATION AT LOCAL PANELS | | | | | FIRE SUPPRESSION SYSTEM FUNCTIONS | | | | | TRANSMIT SIGNALS TO FIRE DEPARTMENT | | | | | | | AUXILIARY FUNCTIONS | | | EVACUATION SIGNALS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Audio-Visual Fire Alarm Indication by Zone | Audio-Visual Trouble Indication by Zone/Middle | Audio-Visual Common Trouble Indication | Audio-Visual Alarm Indication by Device | | Transmit Pump Start Signal to Pumphouse | Open Pre-Action Sprinkler Valves | Open Low Level Spill Fire Suppression System Valves | Divert Drain Flow from Separators to Containment | | Common Trouble Signal Per Building | Common Supervisory Signal Per Building | Common Fire Alarm Per General Area | Sprinkler Water Flow Per General Area | UV/IR Flame Detectors Per General Area | Foam Discharge Per General Area | | Shut Down All Supply & Recirculating Fans | Release magnetically Held Smoke Doors | | Facility Fire Evacuation Audio-Visual Signal | Foam System Signal Blue Strobe/Beacon | |
| | FIRE ALARMS | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W |
| 1 | Manual Fire Alarm Stations | | | | | | | | | | | | | | | | | | | | | | | |
| 2 | Spot-Type Smoke Detectors | | | | | | | | | | | | | | | | | | | | | | | |
| 3 | Fixed Temp & Rate-of-Rise Type Heat Detectors | | | | | | | | | | | | | | | | | | | | | | | |
| 4 | In-Duct Smoke Detectors | | | | | | | | | | | | | | | | | | | | | | | |
| 5 | Rate-Compensated Type Heat Detectors on Hangar Ceiling | X | | | | | X | X | X | X | | | | | | | X | | X | X | | X | X | |
| 6 | Water Flow Switches - Wet or Dry-Pipe Sprinkler Systems | | | | | | | | | | | | | | | | | | | | | | | |
| 7 | Water Flow Switches - Pre-Action Foam-Water Sprinkler Systems | X | | | | | X | | X | X | | | | | | | X | | X | X | | X | X | |
| 8 | Water Switches - Low Level System | X | | | | | | | X | X | | | | | | | X | | X | X | | X | X | |
| 9 | Manual Foam Discharge Station for Low Level | X | | | | | X | X | X | X | | | | | | | X | | X | X | | X | X | |
| 10 | Low Level Optical Fire Detector | | | | X | | | | | | | | | | | X | | | | | | X | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | |
| | SUPERVISORY SIGNALS | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Valve Supervisory Switch - Wet or Dry-Pipe Sprinklers | | | | | | | | | | | | | | | | | | | | | | | |
| 13 | Valve Supervisory Switches -Foam-Water Sprinklers | | X | | | | | | | | | | X | | | | | | | | | | | |
| 14 | Valve Supervisory Switches - Underwing Foam-Water Nozzles | | X | | | | | | | | | | X | | | | | | | | | | | |
| 15 | Valve Supervisory Switches - Water Supply Entrance | | X | | | | | | | | | | X | | | | | | | | | | | |
| 16 | Hi-Lo Pressure Switches - Dry-Pipe Sprinklers | | | | | | | | | | | | | | | | | | | | | | | |
| 17 | Temperature Monitoring System | | | | | | | | | | | | | | | | | | | | | | | |
| 18 | UV/IR Flame Detector Trouble | | X | | | | | | | | | | X | | | | | | | | | | | |
| 19 | Control Component Common Trouble Condition | | X | | | | | | | | | | X | | | | | | | | | | | |
| 20 | Low Level System Auto Disable Switch | | X | | | | | | | | | | X | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | |
| | TROUBLE CONDITIONS | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | Low Battery Voltage | | | X | | | | | | | | X | | | | | | | | | | | | |
| 23 | Circuit Fault | | X | X | | | | | | | | X | | | | | | | | | | | | |
| 24 | Supervised Component Failure | | | X | | | | | | | | X | | | | | | | | | | | | |
| 25 | AC Power Failure | | | X | | | | | | | | X | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES:

1. Fire alarm signals and supervisory alarm signals shall be clearly differentiated at the fire alarm control panel(s).
2 General area means the specific bay, dock, mezzanine, office area, or mechanical area. System zoning shall be sufficient to direct responding firefighters directly to the fire area.
3, This sample matrix shows the basic requirements and is expected to be tailored to each individual project.

Figure A4. Sample Pre-Action FSCP Controls Matrix

**A3.7.1.4.** Control panels activating deluge, pre-action, or nozzle systems must be listed/approved as releasing panels. All releasing panels must be specifically listed/approved for use with the automatic water control valves/solenoid release valves specified for the fire suppression system.

**A3.7.2.** Thermal Fire Detectors. Replace all pneumatic fire detector systems, all other fire detector systems over 30 years old, and any fire detector systems which the manufacturer has ceased to service/support with one of the following automatic fire detection systems at the underside of the roof of the aircraft servicing area. No detection system is required when a wet-pipe fire suppression system is used.

- Rate compensated fire detectors with a temperature rating between 71 °C (160 °F) and 76 °C (170 °F). Maximum area of coverage per detector is 56.25 square meters (625 square feet).
- Linear thermistor (line-type electrical conductivity) fire detectors with a temperature setting of 76 °C (170 °F). Maximum spacing between detection lines is 9 meters (30 feet). The manufacturer must verify the detector response setting after installation using their approved test method. On steeply sloped or curved roofs, thermistor detectors must be installed perpendicular to the slope or arc (along the axis of the curve).

The area covered by the fire detection system must correspond with its affiliated roof-level sprinkler system bound by draft curtains. Activation of any heat detection device in the sprinkler zone immediately:

- sends a start signal to the fire pumping system (if any)
- actuates all low-level fuel spill fire suppression systems in the aircraft servicing area of fire origin
- actuates the appropriate suppression system valves (e.g., pre-action valves, foam concentrate valves) for the floor area covered by the detection system
- activate the facility fire evacuation alarm system and the foam system annunciation signal (if foam is provided)
- transmit a fire alarm signal to the base fire alarm communications center (fire department). The number and type of signals transmitted to the fire department will be locally determined based on the current fire alarm receiving equipment and planned upgrades.

**A3.7.3.** Low-Level Optical Fire Detectors. Remove all single spectrum low-level optical fire detectors. Remove all combination, dual-spectrum, multi-spectrum (ultraviolet/infrared [UV/IR], IR/IR, triple IR) optical detectors over 20 years old. The MAJCOM may approve retaining combination dual-spectrum/multi-spectrum type optical detectors less than 20 years old or installing new, combination dual-spectrum/multi-spectrum type optical detectors for alarm-only applications. Do not use optical detection systems to activate any fire suppression system.

**A3.7.3.1.** Combination, dual-spectrum/multi-spectrum type optical detectors must be listed/approved by a nationally recognized laboratory. Additionally, the

manufacturer must provide a copy of the test report prepared by a nationally recognized laboratory certifying the listed/approved unit will detect a fully developed 3 meter-by-3 meter (10 foot-by-10 foot) JP-4, JP-8, or JET-A fuel fire at a minimum distance of 45 meters (150 feet) within 5 seconds.

**A3.7.3.2.** Optical detectors must be of latching design. Fire detection by any optical detector will immediately:

- activate the facility fire evacuation alarm system
- transmit a fire alarm signal to the fire department.

The number and type of signals transmitted to the fire department will be locally determined based on the current fire alarm receiving equipment.

**A3.7.4.** Waterflow Detecting Devices. Replace waterflow detecting devices over 20 years old. Waterflow detecting devices must be on all fire protection risers. Waterflow switches must have a built-in adjustable (not less than 0 - 90 seconds) retard on all sprinkler systems. Ensure waterflow causes the foam system control panel to accomplish the following actions:

- activates the low level spill fire suppression systems, if installed
- activates the facility fire evacuation alarm system and the foam system annunciation signal
- transmits a fire alarm signal to the fire department. The number and type of signals transmitted to the fire department will be locally determined based on the current fire alarm receiving equipment.

**A3.7.5.** Manual Foam Discharge Stations for Low-Level Fuel Spill Fire Suppression Systems.

**A3.7.5.1.** Locate manual foam discharge stations inside the aircraft servicing area at exits to actuate the low level fuel spill fire suppression systems. Remove any incorrectly located stations.

**A3.7.5.2.** Replace manual foam discharge stations not distinctively different in color from the manual fire alarm stations. Ensure distinctive signage at each device location, stating "Start FOAM System" in red lettering not less than 3 inches in height on a lime yellow background.

**A3.7.5.3.** Ensure manual foam discharge stations are housed within a clear plastic tamper cover that must be lifted before actuating the station.

**A3.7.5.4.** Ensure actuation of any manual foam discharge stations will cause the FSSCP to:

- activate the low level fuel spill fire suppression systems, if installed

- activate the facility fire evacuation alarm system and the foam system annunciation signal
- transmit a fire alarm signal to the fire department. the number and type of signals transmitted to the fire department must be locally determined based on the current fire alarm receiving equipment.

**A3.7.6.** Foam System Signals. Provide blue visual alarm signals (strobe or rotating beacon(s)) within the aircraft servicing area to indicate foam system activation. When the base has adopted a standard audio-visual signal for foam system activation, the signals in this facility must comply fully with that base standard.

**A4. Fire Protection System Water Supply.**

**A4.1.** Requirement. Use the base domestic water system for hangar fire protection systems whenever adequate capacity (flow rate and pressure) is available. The A-E is responsible for testing and determining the capability of the existing systems and integrating those systems with the new systems being designed. When initial analysis indicates the domestic water system is inadequate (flow rate and/or pressure), a cost comparison analysis including life cyle costs must be conducted to determine if it is more ecomonical to upgrade/modify the domestic water system or install one of the following:

- Booster fire pumps when the water flow rate is adequate but pressures are inadequate to meet system pressure demands in accordance with paragraph A4.3.
- A separate dedicated fire protection system water supply when the available domestic flow rate is not sufficient to meet the system flow rate demands.

**A4.2.** Fire Protection Water Storage System.

**A4.2.1.** Ensure water storage tanks comply with NFPA 24. Provide corrosion protection when steel water tanks and associated piping are used. Ensure corrosion protection systems are functional and operating.

**A4.2.2.** Limit water supply distribution mains from a fire pump station to less than 450 meters (1500) feet. The MAJCOM FPE may approve a greater length when specific physical situations justify.

**A4.2.3.** Ensure storage capacity equal to 120 percent of the maximum demand for 30 minutes.

**A4.2.4.** Ensure each tank has a low water level alarm and a low temperature alarm in areas with a 90% dry bulb temperature less than 0 °C (32 °F), each transmitting

back to the fire department as separate supervisory signals. Provide external visual water-level gauging on each tank.

**A4.2.5.** Ensure operational automatic refill from the base water distribution system.

**A4.3.** Fire Protection Water Pump Systems.

**A4.3.1.** Fire protection water pump systems must comply with NFPA 20, *Standard for the Installation of Centrifugal Fire Pumps*.

**A4.3.1.1.** Each pump must have an individual controller. Use "soft start" or variable frequency fire pump controllers when electric-driven fire pumps are installed.

**A4.3.1.2.** Each pump must have an individual relief valve connected to a common return line to the storage tank.

**A4.3.1.3.** Each pump must have a bypass line connected to the return line to the storage tank.

**A4.3.1.4.** The return line to the storage tank must be equipped with a flowmeter for pump testing.

**A4.3.1.5.** The fire pumping system must have capacity to meet maximum water demand when the largest capacity pump is out of service.

**A4.3.1.6.** Arrange multiple-pump installations for sequential starting at 10-second intervals until the required pressure is maintained by the operating pumps. The starting sequence will begin automatically as follows:

- a pump start signal transmitted from the foam system control panel in the protected facility
- drop of water pressure in the system in accordancee with NFPA 20.

**A4.3.1.7.** Provide connection through the installation fire reporting system to notify the fire department of pump running signals, pump system trouble, tamper and supervisory signals provided by the fire pump controllers.

**A4.3.2.** Replacement pump systems must comply with NFPA 20. Use a single fire pumping station for multiple aircraft facilities when practical. Limit water supply distribution mains from a fire pump station to less than 450 meters (1500 feet). The MAJCOM FPE may approve a greater length when specific physical situations justify.

**A4.3.2.1.** New fire pumps must have electric motor drivers conforming to NFPA 20, supplied by a single reliable power source. Use dual power sources when a single reliable power source is not available. Use diesel engine drivers only when the installation electrical service fails to meet the reliable standard and dual power sources are not available. The A-E is responsible for determining and documenting the reliability of the existing power sources. A power source is considered reliable when the following are not exceeded:

- forced downtime, excluding scheduled repairs, more than 8 consecutive hours for any one incident over the previous 3 years; and
- more than 24 hours cumulative downtime during the previous year.

**A4.3.2.2.** Limit the maximum rated capacity of new fire pumps to 9.463$m^3$pm (9463 lpm [2500 gpm]) at 862 kPa (8.5 bar [125 psi]).

**A4.3.3.** Provide pressure maintenance pumps ("jockey pumps") to maintain normal operating pressure on the system and to compensate for normal system leakage. See NFPA 20, paragraph 19, for jockey pump flow requirements. The jockey pump's rated pressure must be sufficient for the startup and shutdown pressures specified in NFPA 20. Set jockey pump controllers to automatically start and stop in accordance with paragraph A-11-2.6 of NFPA 20. Provide run timers to ensure that the jockey pump will run for at least the minimum time recommended by the manufacturer of the jockey pump's motor.

**A5. Facility Fire Detection and Alarm System.** Replace all detection systems not meeting NFPA 72 and the following criteria.

**A5.1.** Fire Alarm Control Panel (FACP).

**A5.1.1.** Locate all FACPs in a clean environment having temperature and humidity control in accordance with the unit's listing/approval.

**A5.1.2.** FACPs must have TVSS on all fire alarm circuits entering and leaving the facility, including but not limited to the power supply circuits to the FACP, circuits interfacing with fire pumping stations outside the facility, and circuits interfacing with the fire alarm receiving station (such as communication circuits or antenna systems). TVSS devices must comply with the requirements of A.3.7.1.2.

**A5.1.3.** Provide a single FACP for all detection alarm functions in the facility not part of the foam-water fire suppression system. The FACP must be fully compatible with the base fire alarm receiving system without field modifications to any system hardware or software.

**A5.1.4.** Separate fire alarm transmitters/receivers are permitted when they are fully compatible with the FACP and the base fire alarm receiving system without field modifications to the FACP.

**A5.1.5.** The specific number of alarm signals to be transmitted will be defined in the system matrix (Figure A5).

**A5.2.** Manual Fire Alarm Stations (Pull Stations).

**A5.2.1.** Ensure manual pull stations are located throughout the facility at required exit doors. Provide additional pull stations when required by NFPA 101.

**A5.2.2.** Ensure manual alarm activation stations are identical throughout the facility. If the base has established a formal base-wide standard for manual pull stations, the pull stations in facilities governed by this ETL must comply fully with that standard.

**A5.2.3.** Actuation of any pull station will immediately cause the FACP to:

- activate the facility fire evacuation alarm signal through out the facility
- transmit a fire alarm signal to the base fire department.

**A5.3.** Fire Alarm Notification. Provide audio-visual alarm notification devices. When the base has a standard for audible sound (e.g., slow whoop, bell) and visual signal (red, white), the devices in this facility must comply fully with the base standard(s). No other system (hangar doors, alert signal) will be permitted to use these signals. Ensure the fire alarm is distinctive in high noise areas.

**A5.4.** Temperature Monitoring System.

**A5.4.1.** Provide a system of temperature sensors for aircraft servicing areas protected by wet-pipe sprinkler systems in all geographic areas having a 99% dry bulb temperature less than –1 °C (30 °F). Temperature monitoring ensures a warning when freezing temperatures endanger sprinkler piping. Locate temperature sensors at the same level as the sprinkler piping, spaced not more than 60 meters (200 feet) apart.

**A5.4.2.** The temperature monitoring system must be tied into the FACP as a dedicated supervisory zone, and this supervisory signal must be transmitted to the fire department in the same manner as all fire-related supervisory signals in the facility.

## SYSTEM INPUTS

| | | ANNUNCIATION AT LOCAL PANELS | | | | | FIRE SUPPRESSION SYSTEM FUNCTIONS | | | | | TRANSMIT SIGNALS TO FIRE DEPARTMENT | | | | | | | AUXILIARY FUNCTIONS | | | EVACUATION SIGNALS | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | Audio-Visual Fire Alarm Indication by Zone | Audio-Visual Trouble Indication by Zone/Middle | Audio-Visual Common Trouble Indication | Audio-Visual Alarm Indication by Device | | Transmit Pump Start Signal to Pumphouse | Open Pre-Action Sprinkler Valves | Open All Foam-Water Nozzle Auto Water Control Valves | Divert Drain Flow from Separators to Containment | | Common Trouble Signal Per Building | Common Supervisory Signal Per Building | Common Fire Alarm Per General Area | Sprinkler Water Flow Per General Area | UV/IR Flame Detectors Per General Area | Foam-Water Discharge Per General Area | | Shut Down All Supply & Recirculating Fans | Release magnetically Held Smoke Doors | | Facility Fire Evacuation Audio-Visual Signal | Foam System Signal Blue Strobe/Beacon | |
| | FIRE ALARMS | A | B | C | D | E | F | G | H | I | J | K | L | M | N | O | P | Q | R | S | T | U | V | W |
| 1 | Manual Fire Alarm Stations | X | | | | | | | | | | | | X | | | | | | X | | X | | |
| 2 | Spot-Type Smoke Detectors | X | | | | | | | | | | | | X | | | | | X | X | | X | | |
| 3 | Fixed Temp & Rate-of-Rise Type Heat Detectors | X | | | | | | | | | | | | X | | | | | | X | | X | | |
| 4 | In-Duct Smoke Detectors | X | | | | | | | | | | | | X | | | | | X | X | | X | | |
| 5 | Rate-Compensated Type Heat Detectors on Hangar Ceiling | | | | | | | | | | | | | | | | | | | | | X | | |
| 6 | Water Flow Switches - Wet or Dry-Pipe Sprinkler Systems | X | | | | | | | | | | | | | X | | | | X | X | | X | | |
| 7 | Water Flow Switches - Pre-Action Foam-Water Sprinkler Systems | | | | | | | | | | | | | | | | | | | | | X | | |
| 8 | Water Switches - Under-Aircraft Foam-Water Nozzles | | | | | | | | | | | | | | | | | | | | | X | | |
| 9 | Manual Foam Discharge Station for Nozzles | | | | | | | | | | | | | | | | | | | | | X | | |
| 10 | Low Level Optical Fire Detector | | | | | | | | | | | | | | | | | | | | | X | | |
| 11 | | | | | | | | | | | | | | | | | | | | | | | | |
| | SUPERVISORY SIGNALS | | | | | | | | | | | | | | | | | | | | | | | |
| 12 | Valve Supervisory Switch - Wet or Dry-Pipe Sprinklers | | X | | | | | | | | | | X | | | | | | | | | | | |
| 13 | Valve Supervisory Switches -Foam-Water Sprinklers | | | | | | | | | | | | | | | | | | | | | | | |
| 14 | Valve Supervisory Switches - Underwing Foam-Water Nozzles | | | | | | | | | | | | | | | | | | | | | | | |
| 15 | Valve Supervisory Switches - Water Supply Entrance | | | | | | | | | | | | | | | | | | | | | | | |
| 16 | Hi-Lo Pressure Switches - Dry-Pipe Sprinklers | | X | | | | | | | | | | X | | | | | | | | | | | |
| 17 | Temperature Monitoring System | | | | X | | | | | | | | X | | | | | | | | | | | |
| 18 | UV/IR Flame Detector Trouble | | | | | | | | | | | | | | | | | | | | | | | |
| 19 | Control Component Common Trouble Condition | | X | | | | | | | | | | X | | | | | | | | | | | |
| 20 | Under-Aircraft Foam-Water System Auto Disable Switch | | | | | | | | | | | | | | | | | | | | | | | |
| 21 | | | | | | | | | | | | | | | | | | | | | | | | |
| | TROUBLE CONDITIONS | | | | | | | | | | | | | | | | | | | | | | | |
| 22 | Low Battery Voltage | | | X | | | | | | | | X | | | | | | | | | | | | |
| 23 | Circuit Fault | | X | X | | | | | | | | X | | | | | | | | | | | | |
| 24 | Supervised Component Failure | | | X | | | | | | | | X | | | | | | | | | | | | |
| 25 | AC Power Failure | | | X | | | | | | | | X | | | | | | | | | | | | |
| 26 | | | | | | | | | | | | | | | | | | | | | | | | |

NOTES:

1. Fire alarm signals and supervisory alarm signals shall be clearly differentiated at the fire alarm control panel(s).
2 General area means the specific bay, dock, mezzanine, office area, or mechanical area. System zoning shall be sufficient to direct responding firefighters directly to the fire area.
3, This sample matrix shows the basic requirements and is expected to be tailored to each individual project.

Figure A5. Sample FACP Controls Matrix

## DISTRIBUTION LIST

DEPARTMENT OF DEFENSE

Defense Commissary Service (1)
Director of Facilities
Bldg 8400
Lackland AFB TX 78236-5000

AAFES/ATTN: CFE (1)
PO Box 660320
Dallas TX 75266-0320

Defense Technical Information Center (1)
ATTN: DTIC-FDA
Alexandria VA 22034-6145

SPECIAL INTEREST ORGANIZATIONS

IHS (A.A. DeSimone) (1)
1990 M Street NW, Suite 400
Washington DC 20036

Construction Criteria Database (1)
National Institute of Bldg Sciences
1201 L Street NW, Suite 400
Washington DC 20005